REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

1. AGENCY USE ONLY (Leave blank)	**2. REPORT DATE** August 1995	**3. REPORT TYPE AND DATES COVERED** Magazine

4. TITLE AND SUBTITLE
Gateway: Volume V, Number 3

5. FUNDING NUMBERS
SPO900-94-D-0001

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8. PERFORMING ORGANIZATION REPORT NUMBER
GWV3

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Defense Technical Information Cntr.
DTIC/AI
Cameron Station
Alexandria, VA 22304-6145

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.
Free to public by contacting the Human Systems IAC.

12b. DISTRIBUTION CODE
A

13. ABSTRACT ***(Maximum 200 Words)***

This issue contains articles on the following subjects:1.Improving Total contact Burn Masks: Three-Dimensional Anthropometric Imaging Techniques; 2.Mac SHAPA: Software Support for Observational Data Analysis; 3.Going Behind the Label "Human Error"; 4.Nuclear Power Plants and Human-System Interfaces

14. SUBJECT TERMS
Image Science Total Contact Burn Masks Exploratory Sequential Data Analysis Human Error Human-System Interfaces

15. NUMBER OF PAGES
20

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNLIMITED

VOLUME V: NUMBER 3 (1994)

CSERIAC GATEWAY

PUBLISHED BY THE CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER

In this issue:

Page

CSERIAC is a United States Department of Defense Information Analysis Center administered by the Defense Technical Information Center, Alexandria, VA, hosted by the Armstrong Laboratory Human Engineering Division, Wright-Patterson Air Force Base, OH, and operated by the University of Dayton Research Institute, Dayton, OH.

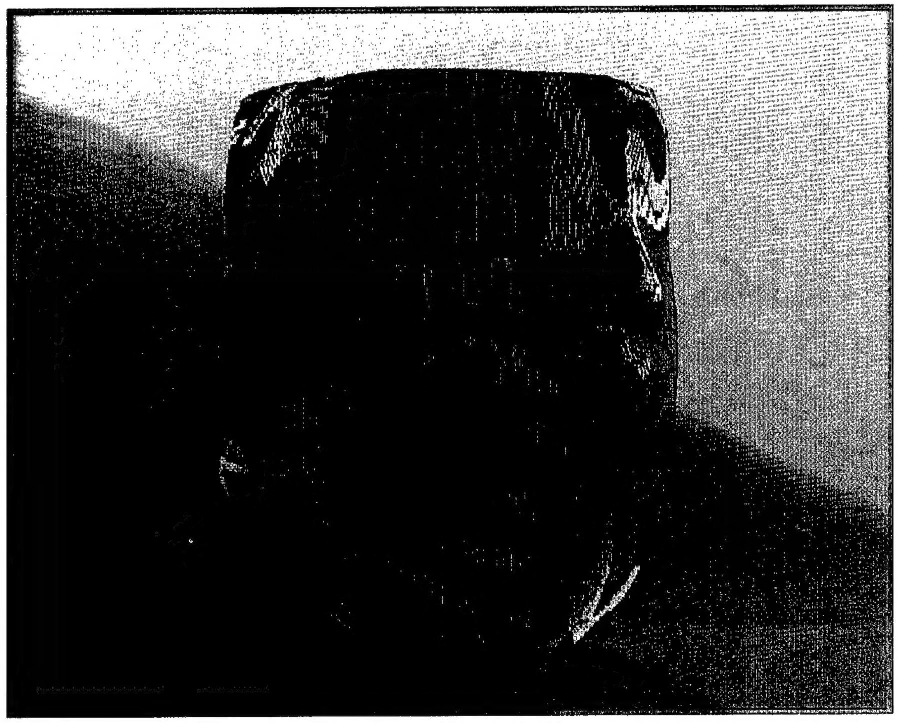

Figure 1. Radial Difference Map (RDM) of a conventional total contact burn mask with respect to a facial scan of a patient. The various colors represent radial differences between the face and the mask. Color graphics generated by Chuck Abruzzino, LTSI.

Improving Total Contact Burn Masks: Three-Dimensional Anthropometric Imaging Techniques

Jennifer J. Whitestone

Image science is an emerging discipline which incorporates electronic imaging technologies and image processing software. For the past five years, the Computerized Anthropometric Research and Design (CARD) Laboratory of the Human Engineering Division at Wright-Patterson Air Force Base has been employing image science to rapidly change the design and evaluation process of craniofacial protective equipment including helmets, masks, and helmet-mounted optic and acoustic systems. The acquisition and manipulation of surface data of the human body and associated equipment items have revolutionized the development of USAF equipment items which interface with the contours of the human body. More recently, tech-

Continued on page 2

nology transfer opportunities have allowed CARD Laboratory researchers to exploit much of this USAF-developed expertise for applications in the medical arena. This article presents one such opportunity–the dual-use application of three-dimensional (3D) anthropometry for rapid prototyping of total contact burn masks (see Fig. 1 for an example of an electronic facial scan used to generate a total contact burn mask). These clear, rigid plastic masks are pressure garments for the face which are worn by burn patients to reduce scar tissue build-up. The application of this technology promises to significantly improve the efficacy of these masks.

Background

Traditionally, anthropometry consists of human body measurements collected using instruments such as calipers and tape measures. These data, however, provide no information regarding shape and, therefore, are limited and quite often misleading when designing equipment which must interface with human body surfaces. Figure 2 illustrates an example of the difficulty encountered when attempting to use traditional anthropometry, or even 3D coordinates of anatomical landmarks, to design masks. Given face length and breadth, and a number of landmark locations, imagine the infinite number of shapes that could potentially meet these criteria and yet not reflect actual human shape. The resulting mask shape derived from these data may not fit facial contours at all! Thus, for successful equipment designs, it is imperative that designers obtain human shape information.

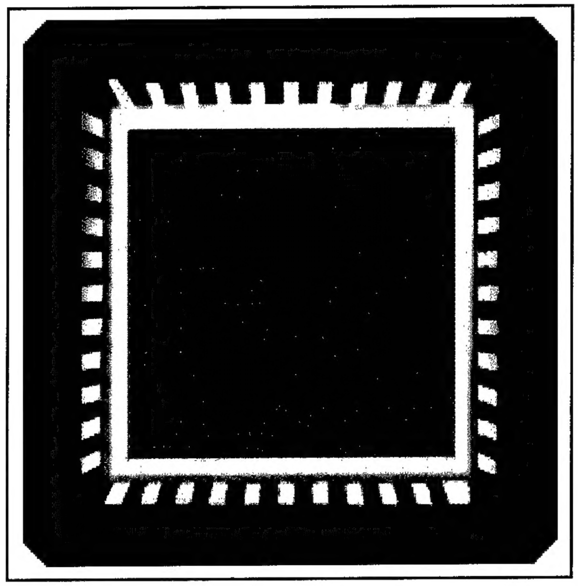

Figure 3. Extraction of profile data from a CCD camera (Cyberware 3D Color Digitizer Model 4020 PS-D).

Many imaging technologies exist which are capable of capturing surface definition of the human body (Vannier, Yates, & Whitestone, 1992). Cyberware, Inc. has developed one such technology, laser scanning, to obtain surface information of the human head. While this color 3D digitizing system was initially developed for commercial portrait sculptor applications, the scientific community discovered that this compact, transportable, rapid scanning system was a useful tool for collecting surfaces of the head, face, and even equipment items. The CARD Laboratory has incorporated the Cyberware scanner for USAF equipment design applications since 1988 and houses an extensive database of image data including over 1500 head scans of civilian and military personnel (male and female), many of which are scanned with their protective equipment to record the human-machine interface (Whitestone, 1993). Surface scanning, and the associated methodologies developed within the CARD Laboratory, have been applied to the evaluation of the MCU-2/P chemical defense respirator, the MBU-20/P oxygen mask, the HGU-53/P helmet, and various other prototype helmet-mounted systems.

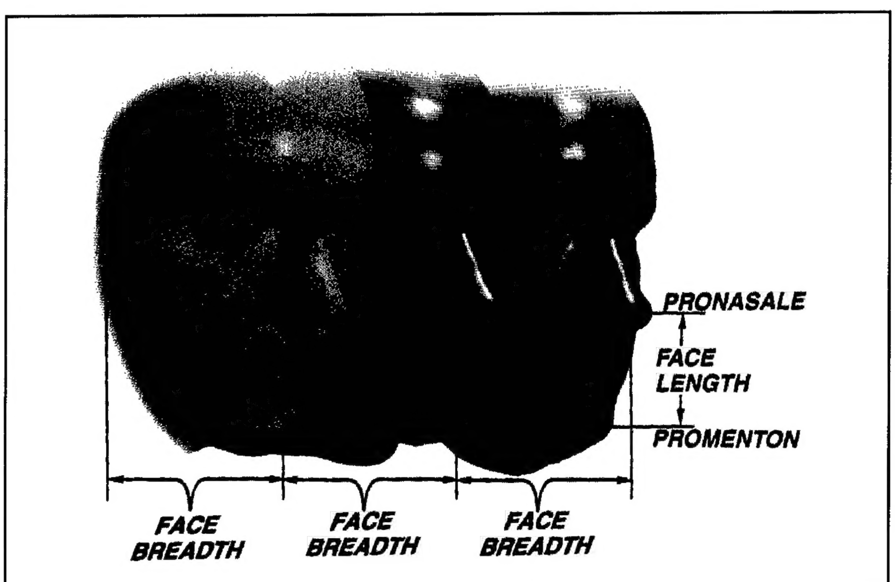

Figure 2. Profiles resulting from traditional anthropometry.

Methods

Image science practiced within the CARD Laboratory consists of two main thrusts: (1) data acquisition and (2) image analysis. The data acquisition system, the Cyberware 3D Color Digitizer Model 4020 PS-D®, operates on the basis of triangulation (Hoffmeister, Kilpatrick, Pohlenz, Addleman, Kasic, Hoeferlin, & Robinette, in press). A helium-neon laser is projected as a plane of light onto the subject located in the center of rotation. As this plane of light intersects the subject, the re-

sulting profile is reflected back to the camera and digitized in a raster fashion as shown in Figure 3. A total of 256 points, approximately 1.5 mm apart, are digitized along each profile for 512 profiles within the entire 360 degrees of rotation. The resulting image is stored as an array, 512 x 256, of radial values from the center of rotation. A second camera is included to record a color value which is directly mapped to each radial point resulting in very realistic color maps. Shown in Figure 4 is a scan of one subject in (a) wireframe format and (b) with the color mapped onto the wireframe.

Successful application of these images toward a given design or evaluation task is entirely dependent upon the ability to visualize, analyze, and manipulate these objects. This second, and probably more critical, thrust is the image analysis software. High-resolution surface scans represent an enormous amount of data, typically more than most Computer-Aided Design (CAD) users are accustomed to manipulating, and so, must be reduced while maintaining critical shape definition. Also, anomalies are often associated with these images, such as spikes, voids, and rough surfaces and must be eliminated, interpolated, smoothed, and otherwise "cleaned up" while maintaining the integrity of the shape information. Methods to quantify shape differences and calculate other quantitative values from surfaces are also needed to effectively apply image data for the wide variety of applications encountered. The functionality required to process these images–data editing routines, analysis algorithms, and visualization software–has been successfully developed, implemented, and validated within INTEGRATE, an in-house software development effort. The most recent test case for INTEGRATE is the development and evaluation of total contact burn masks.

Application to Total Contact Burn Masks

A multidisciplinary team consisting of prosthetists, physicians, physical therapists, and engineers from Miami Valley Hospital, Fidelity Orthopedic, Inc., USAF, and Advent Corporation investigated the use of surface scanning and prototyping methods to improve the fit of total contact burn masks. These burn masks, clear, rigid plastic forms which fit closely to the face, are worn by patients who have received facial burns. Total contact burn masks provide evenly distributed pressure to compensate for the lack of tension in the burned tissue. The mask is worn continually throughout the healing process and acts to reduce hypertrophic scarring. There are several benefits associated with this clear plastic material. First, the plastic can be molded to more closely fit contours of the face; second, the mask can be adjusted by spot-heating specific areas; third, the face can be visualized to ensure scars receive adequate pressure as indicated by vascular blanching; and fourth, the transparent mask is more cosmetically appealing to patients (Staley & Richard, 1994). The burned tissue, as it heals, responds dramatically to the shape of the mask. Therefore, the mask itself represents the end product which is ultimately the resulting shape of the patient's face.

Conventional fabrication of these masks requires the application of alginate and plaster to the face to capture the surface data. This slow and uncomfortable process can be risky (if all wounds have not completely healed) and anxiety provoking, especially for children, often requiring anesthesia. Even with the skills of a highly talented clinician proficient at fabricating these masks, the effects of gravity and material weight cannot be counterbalanced and can considerably alter the final shape of the mask.

Approach

The method of applying image science and prototyping methods to the fabrication process of state-of-the-art (SOTA) masks was developed by the multi-disciplinary team. Fabricating the SOTA masks consists of three steps: (1) acquiring and editing the image data, (2) replicating the image in physical form, and (3) fabricating the mask from the positive form. Only steps (1) and (2) differ considerably from the conventional method.

The electronic image data of the patient is acquired using the Cyberware scanner and transferred to INTEGRATE, hosted on a Silicon Graphics® workstation. INTEGRATE is used to edit,

Continued on page 4

Figure 4. Cyberware scan data of a subject (a) in a wireframe format and (b) with a color map.

process, and format the image data for incorporation into the CAD environment. Once in the CAD system, the image is re-sampled to increase the resolution of the image data. Cyberware scan resolution is approximately 1 mm while the resolution required by Computerized Numerically Controlled (CNC) milling process is considerably higher. The offset tool path, optimized for the shape and size of the selected end mill, is generated within the CAD system and the data are formatted for input to CAM (Computer-Aided Manufacturing). Ren Shape 350®, manufactured by Ciba-Geigy, Inc. is used as the prototype material for ease of use in the machining process. The final positive form is used identically to the plaster positive form developed during the conventional process to vacuum form the mask. Masks for three burn patients were fabricated both in the conventional manner and using the state-of-the-art methods described. The masks are being evaluated both clinically and quantitatively.

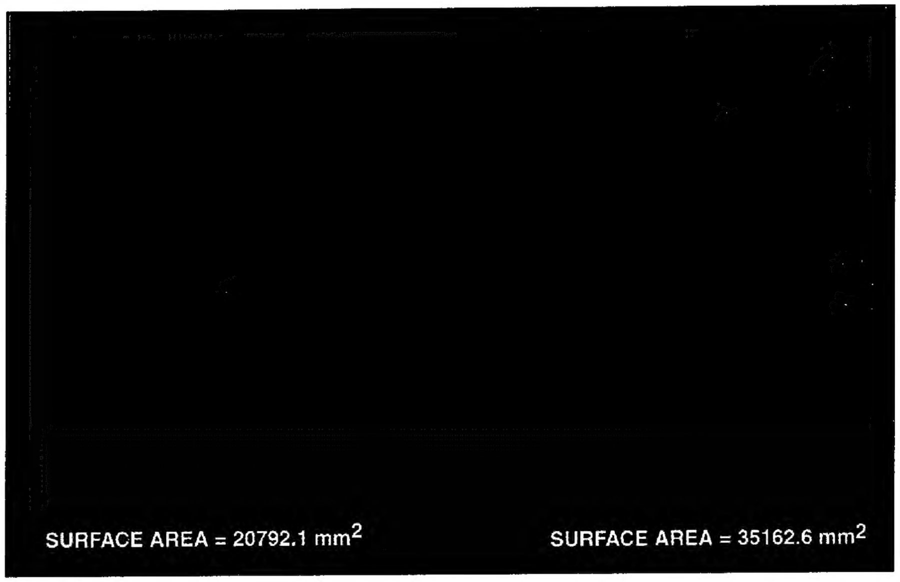

Figure 6. Surface areas representing 2mm or less radial difference between mask and face for (a) a conventional mask and (b) a SOTA mask.

Results

As the clinical outcome of these masks is still under investigation, the results of this preliminary study are presented in a demonstrative fashion to describe the methods used to evaluate 3D shape. Figure 5 shows a profile view of the patient's face compared to the SOTA and conventional masks. Clearly, the SOTA mask displays better definition and more accurately represents the contours from the patient's face. Furthermore, a quantitative analysis of the masks can be used to interrogate the "fit," that is, the ability of the mask to conform to the contours of the face. Figure 1 shows a radial difference map (RDM) which displays quantitative differences from the surface of the subject's facial scan to the conventional mask surface. The various colors represent separate intervals (1mm, 2mm, etc.) of these radial differences. The larger the differences, the poorer the "fit." For demonstration purposes, the surfaces of the masks representing 2mm or less radial differences from the facial scan are shown in Figure 6. Surface areas were calculated for both masks. (Volumes for these regions, difference volumes, can also be calculated.) The SOTA mask, resulting in a larger surface area, more accurately follows the contours of the face. As this mask better duplicates the subject's face, the result is a better "fit."

Figure 5. Profile of a patient's face with respect to (a) a conventional mask and (b) a SOTA mask.

Future Work

Based on documentation describing the methods from this feasibility study, the International Association of Firefighters has funded Phase II of this effort. Phase II will involve fabrication of both SOTA and conventional masks for a total of five subjects, clinical fit evaluations of these masks, and quantitative analyses of the mask images including RDM, calculated volume differences, and fit scores. Additionally, fabrication of the mask directly using stereolithography, a rapid prototyping method which could eliminate the need for a positive mold, is being investigated. ○

GATEWAY

Calendar

February 20-23, 1995
San Diego, CA, USA
Occupational Ergonomics: Work Evaluation and Prevention of Upper Limb and Back Disorders. A short course sponsored by The University of Michigan, American Industrial Hygiene Association (San Diego), and the State Compensation Insurance Fund of California. Contact Conlin/Farber Travel, P. O. Box 1207, Ann Arbor, MI 48106-1207; 1 (800) 426-6546.

February 24-25, 1995
San Diego, CA, USA
Ergonomic Job Analysis. A short course sponsored by The University of Michigan, American Industrial Hygiene Association (San Diego), and the State Compensation Insurance Fund of California. Contact Conlin/Farber Travel, P. O. Box 1207, Ann Arbor, MI 48106-1207; 1 (800) 426-6546. *The preceding course, Occupational Ergonomics, or equivalent ergonomics training, is a prerequisite.*

March 26-28, 1995
Blacksburg, VA, USA
3rd Mid-Atlantic Human Factors Conference. Contact Jonathan Kies, 271 Whittemore Hall, Dept. of ISE, Virginia Tech, Blacksburg, VA 24061-0118; fax (703) 231-3322, email: confer@csgrad.cs.vt.edu.

April 4-6, 1995
Canterbury, Kent, UK
The Ergonomics Society Annual Conference 1995. Contact the Conference Manager, The Ergonomics Society, Devonshire House, Devonshire Square, Loughborough, Leicestershire LE11 3DW, UK; telephone/fax +44 (509) 234904.

April 23-27, 1995
Columbus, OH, USA
Eighth International Symposium on Aviation Psychology. Contact Dr. Richard S. Jensen, Symposium Chair, or Lori A. Rakovan, Technical Chair, The Ohio State University Department of Aviation, Aviation Building, 164 West 19th Avenue, Columbus, OH 43210; (614) 292-2405, fax (614) 292-1014.

April 24-28, 1995
Dayton, OH, USA
6th Annual Aerospace Atlantic Conference & Exposition, "Partnering for a Lean Aerospace Environment." Sponsored by SAE. For papers, contact Ms. Karen Mong, SAE Aerospace Atlantic '95, 400 Commonwealth Dr., Warrendale, PA 15096; fax (412) 776-1830. For exhibits, contact Mr. Patrick Cantini, SAE Exhibits Division at (412) 772-7174.

May 7-11, 1995
Denver, CO, USA
CHI '95. Contact CHI '95 Conference Office, 703 Giddings Ave., Suite U-3, Annapolis, MD 21401; (410) 263-5382, fax (410) 267-0332, email: chi95-office@sigchi.acm.org.

May 22-24, 1995
San Jose, CA, USA
Silicon Valley Ergonomics Conference & Exposition (ErgoCon '95). Contact Dr. Abbas Moallem, Program Chair, ErgoCon '95, One Washington Square, San Jose, CA 95192-0180; (408) 924-4132, fax (408) 924-4153. For exhibits, contact the ErgoCon '95 Coordinator, 2603 Main Street, Suite 690, Irvine, CA 92714; (714) 752-7866, fax (714) 752-7444.

June 13-16, 1995
Seattle, WA, USA
The 1995 Industrial Ergonomics and Safety Conference. Contact Dr. Alvah Bittner, Battelle, P.O. Box C5395, 4000 N.E. 41st Street, Seattle, WA 98105-5428. Fax (206) 528-3552.

June 19, 1995
Orlando, FL, USA
Safety Technology 2000. Contact American Society of Safety Engineers, 1800 E. Oakton St., Des Plaines, IL 60018-2187; (708) 692-4121 ext. 56 or 707.

June 19-22, 1995
Orlando, FL, USA
American Society of Safety Engineers 34th Professional Development Conference and Exposition. Contact American Society of Safety Engineers, 1800 E. Oakton St., Des Plaines, IL 60018-2187; (708) 692-4121 ext. 223, fax (708) 296-3769.

September 24-28, 1995
Montréal, Québec, Canada
2nd International Scientific Conference on Prevention of Work-Related Musculoskeletal Disorders, PREMUS 95. Organized by the Institut de recherche en santé et en sécurité du travail du Québec (IRSST) under the auspices of the Scientific Committee on Musculoskeletal Disorders of the International Commission on Occupational Health. Contact IRSST, 505, Boulevarde de Maisonneuve Ouest, Montréal, Québec, Canada, H3A 3C2; (514) 288-1551, fax (514) 288-7636. *Abstracts due March 15, 1995.*

Notices for the calendar should be sent at least four months in advance to:
CSERIAC Gateway Calendar, AL/CFH/CSERIAC Bldg 248, 2255 H Street, Wright-Patterson AFB OH 45433-7022

For further information on the development of the total contact burn mask and the CARD Laboratory, contact:

Jennifer J. Whitestone
AL/CFHD
2255 H Street Bldg 248A
Wright-Patterson AFB OH
45433-7022 (513) 255-8870

Jennifer J. Whitestone is a Biomedical Engineer with the Design Technology Branch, Armstrong Laboratory Human Engineering Division, Wright-Patterson Air Force Base, OH.

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Whitestone, J.J. (1993). Design and Evaluation of Helmet Systems Using 3D Data. *Proceedings of the 37th Annual Meeting of the Human Factors and Ergonomics Society,* Santa Monica, CA.

Hoffmeister, J., Kilpatrick, B., Pohlenz, M., Addleman, D., Kasic, M., Hoeferlin, D., & Robinette, K. (In press). *Functional Description of the Cyberware Color 3D Digitizer 4020 RGB/PSD* (Armstrong Laboratory Technical Report). Wright-Patterson AFB, OH: Armstrong Laboratory.

Staley, M.J., & Richard, R.L. (1994). Scar Management. In R. L. Richard & M. J. Staley (Eds.), *Burn care and rehabilitation: Principles and practice* (p. 391). Philadelphia: F.A. Davis.

The COTR Speaks

Reuben L. Hann

We're on the "Web"

CSERIAC is on the Information Superhighway! Well, actually, we have been there for some time, but the reason for the excitement is that now we are accessible on the World-Wide Web (WWW) with our own *Home Page.* As users of this network already know, this will make CSERIAC information services available via an easy-to-use InterNet browser interface such as Mosaic® or Netscape®. Being on the WWW allows CSERIAC to present information in full-color high-resolution graphic form, as well as the capability to add sound and motion when desired. If you haven't experienced this new way of interacting with the world of information out there, it is time for you to give it a try. See our announcement on p. 8.

This issue of *Gateway*

This issue begins with a feature on the Total Contact Burn Mask, developed in the Computerized Anthropometric Research and Design (CARD) Laboratory of the Armstrong Laboratory Human Engineering Division. Jennie Whitestone, Research Engineer from the Design Technology Branch, provides an overview of the 3-D imaging technique used to create these masks and how they have revolutionized the treatment of facial burns.

Because of the importance of the technology underlying the Total Contact Burn Mask, the Editor is reprinting an earlier *Gateway* (Vol. IV, No. 4) article on the *Proceedings of the Working Group on Electonic Imaging of the Human Body.* This article, also written by Jennie Whitestone, can be found on page 19. For those readers interested in additional information about electronic imaging technology, copies of these *Proceedings* are available through CSERIAC.

In this issue we present an edited version of a conversation I had with Dick Pew (BBN Systems &Technologies) when he was here as the sixth speaker in the 1993 Armstrong Laboratory Human Engineering Division Colloquium Series: The Human-Computer Interface. A synopsis of his presentation on Situation Awareness appeared in a previous issue of *Gateway* (Vol. V, No. 1).

Of special interest to those readers involved in the collection of observational data is the release of a new software package called MacSHAPA. Penny Sanderson (University of Illinois), the primary developer of MacSHAPA, enlightens us with her article on the fundamentals of using this new software tool. This tool is available exclusively through CSERIAC.

It is with pleasure that we announce an important new publication, soon to be available from CSERIAC. David Woods, Leila Johannesen, Richard Cook, and Nadine Sarter (The Ohio State University) have just completed a CSERIAC-commissioned state-of-the-art report entitled *Behind Human Error: Cognitive Systems, Computers, and Hindsight.* In this issue of *Gateway,* Leila Johannesen gives us a synopsis of the report which will be available from CSERIAC beginning in February 1995.

Rounding out this issue, Ken Klauer (CSERIAC Human Factors Analyst) continues his discussion of CSERIAC's Technical Inquiry Services by describing a Review & Analysis on the subject of the human-system interface in nuclear power plant control rooms. This project was generated at the request of the Nuclear Regulatory Commission (NRC) and serves to illustrate the next level of CSERIAC's Technical Inquiry Service beyond the basic Search & Summary discussed in the last issue (Vol. V, No. 2).

Six years of service

I would also like to note that we have just ended our sixth year of service to the ergonomics and design communities. During this time, some of the accomplishments have been development of an active technology transfer program, where taxpayer-funded technologies are made available to the broader user community; providing responses to more than 2200 technical inquiries from every conceivable type of governmental, commercial, and academic organization; publication of five State-of-the-Art Reports, one Critical Review, and two workshop proceedings; maintenance of public awareness through the *Gateway,* the Armstrong Laboratory Human Engineering Division Colloquium Series, conducting several conferences, and various marketing campaigns; and the development of a state-of-the-art in-house management information system to provide accounting information, library records, customer records, expert network, and product and sales information. We look forward to providing ergonomics information services to an increasing number of users in the years to come. If you have not tried CSERIAC yet, please don't hesitate to contact us whenever you need help with an ergonomics/human factors problem. ●

Reuben "Lew" Hann, Ph.D., is the Contracting Officer's Technical Representative (COTR) who serves as the Government Manager for the CSERIAC Program.

GATEWAY

Announcements

Ergonomics In Design Welcomes Your Submission

Ergonomics In Design provides information on applications of human factors/ergonomics and informs readers about the potential contributions that human factors professionals can make to the design of any system, tool, environment, or product with which people interact.

Articles describing the application of human factors/ergonomics principles are welcome. We are particularly interested in how the application and/or process by which it was implemented may benefit readers, whether they are working or merely interested in the field. Articles should be written in a less formal style than that used for a journal but suitable for professionals of varied educational and professional backgrounds.

Feature articles should be 1500-3000 words in length; short pieces are also acceptable and should not exceed 1500 words. All text (including references) should be typed double-space on one side of each page. Illustrative materials (photos, illustrations, tables, graphs) are encouraged. Send four copies to:

Daryle Jean Gardner-Bonneau, *EID* Editor
Human Factors and Ergonomics Society
P.O. Box 1369
Santa Monica, CA 90406-1369 USA

All submissions are acknowledged on receipt. Please allow 12 weeks for technical review. Sample issue and detailed manuscript guidelines are available from the address above (FAX 310/394-1811).

Human Factors and Ergonomics Society Fellows Elected

Five distinguished nominees were recently elected Fellows of the Human Factors and Ergonomics Society. They are:

John G. Casali, Professor of Industrial and Systems Engineering, and Director of the Auditory Systems Laboratory, Virginia Tech, Blacksburg, VA.

Susan M. Dray, President of Dray & Associates, Minneapolis, MN.

Raja Parasuraman, Professor of Psychology and Director of the Cognitive Science Laboratory, Catholic University of America, Washington, DC.

William B. Rouse, Chief Executive Officer of Search Technology, Inc., Atlanta, GA.

David D. Woods, Associate Professor of Industrial and Systems Engineering, and Codirector of the Cognitive Systems Engineering Laboratory, The Ohio State University, Columbus, OH.

Human Factors and Ergonomics Society Placement Service

The Human Factors and Ergonomics Society (HFES) offers an opportunity for employers seeking human factors/ergonomics expertise to tap into the tremendous knowledge base and range of experience of HFES members and other professionals in related fields.

Candidates are computer-matched with available jobs on the following criteria:

Highest degree held	Areas of interest
Major field of study	Employment sector
Years of experience	Geographical Area
Salary	Type of position

The HFES Placement Service can help in filling full-time, part-time, or consulting positions. Both members and nonmembers may use the service for renewable four-month terms. Anonymity will be maintained if requested by the user.

Call HFES at (310) 394-1811 or fax (310) 394-2410 to obtain rates and application forms.

CSERIAC ON THE "WEB"!

With a few strokes on your keyboard you can access on-line information about CSERIAC via the World-Wide Web. Information currently available includes:

- *Gateway*, 1994, Issues 1 & 2
- CSERIAC general information
- CSERIAC products and services information

To access the CSERIAC home-page directly enter:

- http://www.dtic.dla.mil/iac/cseriac/IAC.HTML

Information about other IACs can be obtained by entering:

- http://www.dtic.dla.mil/iac/

For question about accessing CSERIAC through the World-Wide Web, contact Chris Sharbaugh, CSERIAC Technology Transfer Analyst, at (513) 255-4842.

Armstrong Laboratory Human Engineering Division Colloquium Series
A Conversation With Richard Pew

Reuben L. Hann

Editor's note: Following is an edited transcript of a conversation with Dr. Richard Pew, BBN Inc., who had just made a presentation on the topic of Situation Awareness as the sixth and final speaker in the 1993 Armstrong Laboratory Human Engineering Division Colloquium Series: The Human-Computer Interface. As his colloquium lecture served as a feature article in Volume V, Issue 1 (1994) of Gateway, it does not appear here. The interviewer was Dr. Lew Hann, CSERIAC COTR. JAL

CSERIAC: I see in your biography that your undergraduate degree is in electrical engineering. How did you make the transition to psychology?

Dr. Pew: The way I got started was with the reading of an article by Birmingham and Taylor in an Institute of Radio Engineers (IRE) publication. It was about man-operated continuous control systems. I was taking a course in servomechanisms at the time, what today would be called control systems, and I had already decided that I did not want to design circuits the rest of my life. I wanted to do something involving people. So this article immediately captured my imagination. To that paper I attribute my introduction to the field.

I also took a course in acoustics. The only requirement for the course was to write a paper. I wrote about information theory, speech, and acoustics and unknowingly cut my teeth in the field that would later be characterized as human information processing. That was in 1954, when Claude Shannon was breaking new ground in information theory.

After a stint in the Air Force at the Aeromedical Lab, I spent a year at Harvard that was my formal baptism into psychology. Next, at the University of Michigan, I did take some control engineering courses, although most of my course work and my degree were in psychology.

CSERIAC: In this regard, I would like to get your opinion of human factors education. Some institutions offer basically an engineering course, with some psychology electives, while other schools are heavy on experimental psychology and add some engineering courses. What is the best way to educate human factors professionals?

Dr. Pew: If you want to do ergonomics or industrial system design, then I think it is fine to get your human factors training in an industrial engineering department. If you want to do cognitive science applications, things for which a "deep understanding of human information processing" is important, I think it is very difficult to get that in an engineering school. It is possible, in those cases where there are engineering departments with psychologists on their staff, such as VPI (Virginia Polytechnic Institute and State University) at Blacksburg, but they are the exception rather than the rule.

"Good design is transparent design.... That is, the best interface design is one that is so well adapted to its application that there is no training or learning involved."

CSERIAC: In fact, more and more frequently we are hearing people describe themselves as "cognitive engineers."

Dr. Pew: Yes, but I think that the "feel for experimentation" and the "intellectual understanding of how people work" really require more than what is available from taking a course or two in psychology from an engineering base. That's a biased point of view, because that's where I come from, but I really believe it. Now, of course there have been some notable exceptions to this, like Jens Rasmussen, but they are not the same kind of specialist that comes from psychology.

CSERIAC: In a related area, what is your opinion of the push to certify human factors practitioners? What about the problem of evaluating practitioners in a multi-disciplinary field?

Dr. Pew: I think it's feasible. I believe there are many other multi-disciplinary areas which provide potential models, where certification has been done successfully. Acoustics is one of them, for example. I think we are taking a narrow perspective to believe that ours is the only broad, interdisciplinary field. I don't think you can have a qualification that insists that everyone know everything in the field, but I do think you can write a general qualification test in which there are some basic things everyone should know. Then you can take one or two tests from an optional set of specialized exams in areas in which you claim to be knowledgeable. That's the way I think the human factors certification board is approaching it.

As to whether it is the right thing to do, I believe the jury is out on that. I think I would vote for having a certi-

Continued on page 10

fication program, but the place "where the rubber meets the road" is whether I want to sign up or not. I haven't, so far, crossed the threshold where it is so important for me to be certified that I will pay the money and do all the work to prepare all the materials, even though I could do it as a "grandfather." That's a judgment at this stage of my career; I might have a different view if I were 30 years old.

CSERIAC: One of the previous speakers in our series, David Woods (The Ohio State University), spoke of "clumsy automation," where human-system interfaces are made needlessly complex, using the technology "because it's there." Also, the sharing of the burden between human and computer sometimes seems to be shifted too much in the direction of the computer. It seems that these concerns are very much related to problems in situation awareness.

Dr. Pew: Yes, absolutely. In the work we are doing for NASA Langley we are working now on an experiment concerning a set of decision-aiding technology they call *Fault Finder*, which is supposed to detect and identify incipient failures in commercial aircraft systems. The research question is, how far should the automated system go? That is, should it simply report that there is an inconsistency in data? Should it interpret those inconsistencies, and say that there has been an engine failure? Or, should it make a recommendation as to what the crew member should do? These are general issues that impact on situation awareness and that apply to human-computer interaction in general, not just to aircraft.

CSERIAC: What are some non-aircraft situations where situation awareness is important? I believe you mentioned something about it with regard to fire-fighting?

Dr. Pew: Yes, I talked about fire commanders, and about the changed situation when a fire crosses the firebreak line. Actually, any command and control setting has severe situation awareness requirements. But even the seemingly simple act

Scenes from the Armstrong Laboratory Human Engineering Division Colloquium Series:

Dr. Pew presents his definition of situation awareness to an audience at Wright-Patterson Air Force Base, OH.

Dr. Pew concluded his presentation with discussing three ways to differentiate situation awareness as a general concept as opposed to an operational human performance concept.

of driving a car involves situation awareness. The skilled driver knows where all the cars are in the surounding area, knows what the fuel status is, whether the cruise control is on, and is fully cognizant of the state of the vehicle at all times.

CSERIAC: It seems to me that situation awareness considerations would also be important in the design of virtual reality systems.

Dr. Pew: Yes, in fact I have been working with a National Research Council committee on virtual reality. At the last meeting, for example, we were advocating the development of standardized indices of spatial awareness, because one of the differences between a virtual environment and a standard simulator is often the extent to which spatial location and orientation can be represented and communicated cleanly. So, when we are looking for the advantages of a virtual environment, one of the dimensions should be improvement in spatial awareness.

CSERIAC: It's probably an over-simplification, but I have noticed in my interactions with the various speakers in this series that the problems of dealing with human error seem to be part of virtually all human factors activities these days. It is almost as though human error prevention in some form is synonymous with human factors.

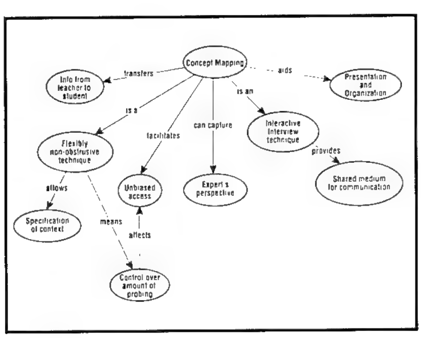
Dr. Pew: Well, good design is transparent design. If the design is good, then (a) people don't make errors and (b) they don't think about the fact that they are interacting through a specific human-computer interface. That is, the best interface design is one that is so well adapted to its application that there is no training or learning involved, because it is so natural that one just does it. To the extent that a system fits this description, people reduce errors.

However, I think of four kinds of criteria human factors people are promoting, only one of which is the reduction of human error. Second is efficiency, improved performance per unit of time. Third is user acceptance; more and more frequently there is market competition, based on which product people like better. Fourth is learnability, minimizing the requirement for training.

There is one other, a fifth criteria I should mention, although it is a bit more remote: adaptability to change. I believe that one characteristic of a good system is its ability to easily adapt to unanticipated user needs. This is a paradox, since, if you knew what these "unanticipated needs" were, you would have designed for them. So, it's difficult, but I do believe that there is a way to approach this. It involves the notion of loosely versus closely coupled systems. A loosely coupled system is one in which there are not severe time constraints and a task can be accomplished in more than one way. A closely coupled system is one that is not forgiving. If an operator fails to accomplish a task in the specified way, a failure occurs. A loosely coupled system is more likely to adapt to changing conditions than one that is closely coupled. So if you can achieve the goals of the system efficiently using a loosely coupled approach, then I think that is the preferred design. ●

TAKE A LOOK!

Tools for Automated Knowledge (TAKE) from the Armstrong Laboratory Human Engineering Division



A concept map derived from TAKE

Concept Mapping software for use during system specification and development, user requirement identification, function identification, and task analysis. TAKE is designed to help you map, organize, categorize, and retrieve the volumes of information provided by subject-matter experts and end-users during knowledge elicitation. TAKE runs on a Macintosh Computer System 7.0.

Look for the article in the next issue of Gateway. TAKE will be available this Spring. For further information, contact the CSERIAC Technology Transfer Analyst at (513) 255-4842.

MacSHAPA: Software Support for Observational Data Analysis

Penelope M. Sanderson

Whether pursuing fundamental research issues, gathering requirements for design, or evaluating prototypes, human factors investigators often collect data from people performing real-world tasks. The goal might be to understand working relations captured in cockpit voice recordings, seek cause-effect relations between system states and human errors in high-fidelity aviation or industrial simulators, or model collaborative work activities from video records.

In some cases, investigators simply make notes while observing people at work. In other cases, video recordings are made that allow more detailed analyses later. Increasingly, control activities can be recorded electronically while people work on computers or in simulators. However, the result is always a great deal of data to analyze.

Unfortunately, our ability to analyze the rich data we can now collect has not kept up very well with our ability to collect it. Moreover, the fact that we can collect rich data almost suggests that we must analyze it all in detail. It is seldom clear what the best way to analyze complex multimedia observational data will be. To some extent this is because we have not yet experienced full control over such data, manipulating and exploring it, and thereby developing effective analytic practices. Overall then, this kind of data analysis—recently termed exploratory sequential data analysis or ESDA for short (Sanderson & Fisher, 1994)—is still conceptually difficult and very time-consuming.

MacSHAPA is one of a number of software tools now emerging to help with the problems of ESDA (for other examples see Sanderson, 1994). MacSHAPA does not help with every kind of ESDA—no software tool can—but it does help with certain kinds. Very briefly, MacSHAPA lets investigators do the following:

- Enter or import data into a spreadsheet-like viewing medium
- Annotate, manipulate, and visualize data in various ways
- Carry out statistical analyses of various kinds
- Export data and results to other applications.

MacSHAPA has simple multimedia capabilities: investigators can control a VCR from the Macintosh, using MacSHAPA to play, pause, stop, rewind, fast forward, jog, and shuttle at different speeds.

MacSHAPA lets investigators capture timecodes from video, insert them into the data, and find a videotape location that corresponds to a timestamp selected in the data. Video can be displayed on an external monitor, as shown in Figure 1. Alternatively, with the appropriate hardware and software, video can be displayed on the computer screen alongside the data, as shown in Figure 2. By using third-party software connected to MacSHAPA, different kinds of video devices can be used.

Qualitative and quantitative analysis activities are both supported by MacSHAPA. For example, an investigator may just want to browse video records, making unstructured qualitative comments that can later be searched or used to access interesting parts of the video.

Alternatively, an investigator can develop sophisticated coding schemes within MacSHAPA, apply these cod-

Figure 1. MacSHAPA in use at the University of Illinois.

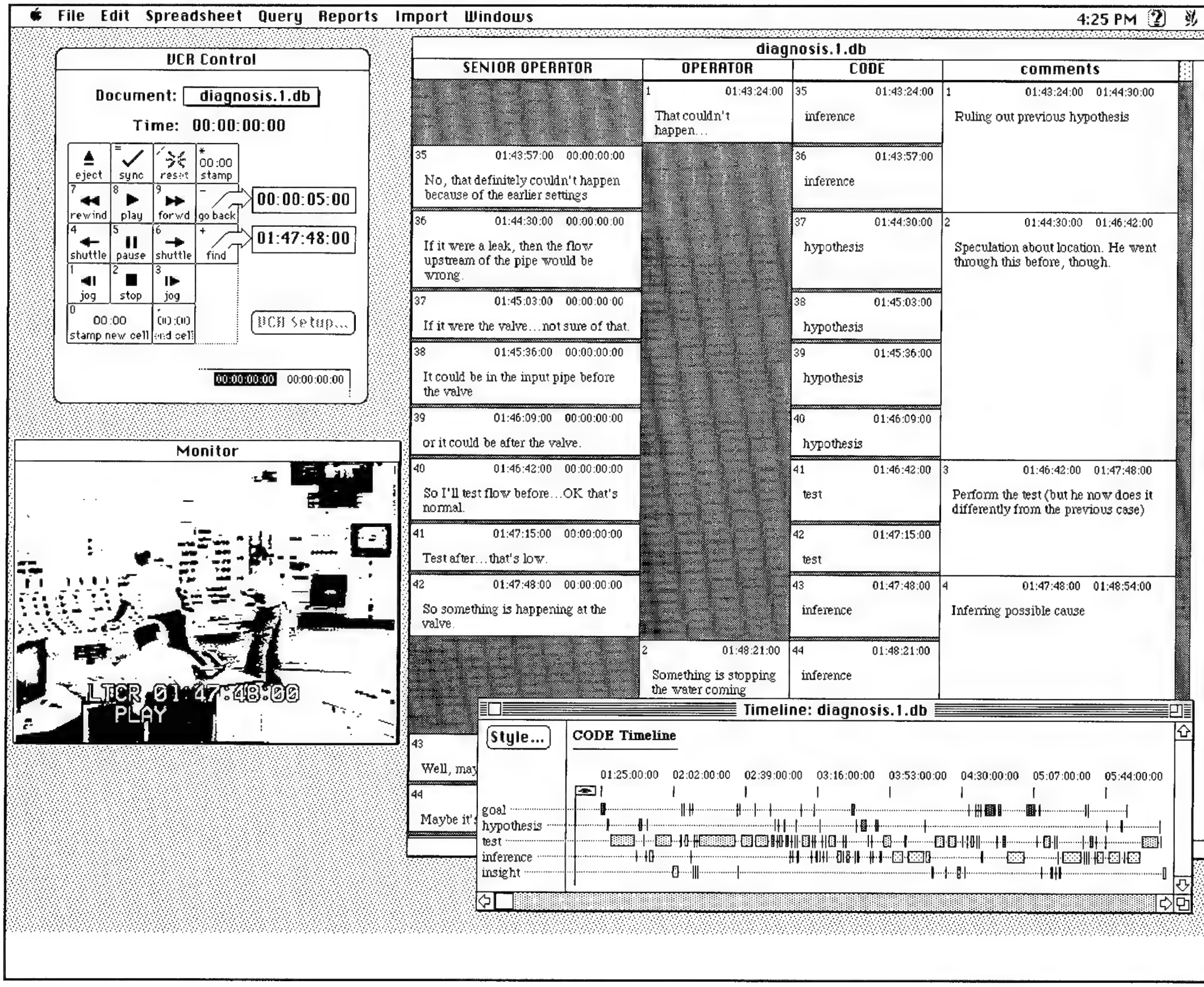


Figure 2. At upper right, MacSHAPA's spreadsheet-like document window; at lower right, a timeline display; at upper left, the VCR control window; and at lower left, digitized video of a process control environment.

ing schemes to the video and electronic records, change the schemes as needed, and use statistical routines to analyze the data once fully encoded. For example, the document pictured in Figure 2 includes both formal codes and unstructured comments.

MacSHAPA's statistical routines include content analysis, duration analysis, transition analyses (and simple Markov analysis), lag sequential analysis, reliability measures such as Cohen's kappa and information theoretical measures, and cycles reports.

Finally, MacSHAPA offers a simple query language that allows investigators to ask questions of their data that might not be supported by the statistical routines already within MacSHAPA.

Some kinds of ESDA can be conveniently supported with MacSHAPA, whereas it is less suitable for other kinds. For example, the software was designed to be used primarily with symbolic data, such as codes describing human and system activity. At present, MacSHAPA has less to offer to the analysis of numerical data such as tracking performance or raw eye-movement data.

Temporal relations are an important organizing principle in MacSHAPA. Comments and annotations, as well as events, are associated with a particular point in time. Because of this, MacSHAPA is particularly useful for analyzing sequential and linear aspects of observational data but is of less help when analyzing non-linear aspects.

There are no coding categories "built" into MacSHAPA, and the software does not encode data automatically. Instead, MacSHAPA helps investigators develop and change coding categories, store them, and use them to encode data manually.

In an important sense, then, MacSHAPA represents the implemen-

Continued on page 14

tation of a preliminary hypothesis about how certain kinds of ESDA might be aided. The software is primarily a research tool developed in a research laboratory, and does not have some of the features expected of a commercial software product. However, it is continually evolving in response to user comments.

Users are supported with email mailing lists that we maintain at the University of Illinois. A general mailing list allows users to answer each other's questions and pass ideas amongst themselves. It also lets the development team pass information to the whole community of users. More specific lists let users send specific questions or reports of problems to the MacSHAPA development team, which we field as best we can with our limited resources.

MacSHAPA comes with an 800-page manual that describes and illustrates the software's features and functionality in detail. The manual also includes three tutorials, one introductory and the other two on more advanced topics. Workshops on the use of MacSHAPA—and surveys of related tools—can also be arranged.

In summary, our goal in developing MacSHAPA has been to help effective methods emerge for analyzing observational and sequential data. We hope that the software will put investigators in much closer contact with their data, and allow them to carry out useful analyses they would not otherwise contemplate. ●

Support

MacSHAPA was developed with support from the Rotorcraft Human Factors Branch, NASA-Ames Research Center; the Armstrong Laboratory Human Engineering Division, Wright-Patterson Air Force Base; the Air Operations Division, Aeronautical and Maritime Research Laboratory, Defence Science and Technology Organisation, Australia; and the University of Illinois Research Board.

MacSHAPA was programmed by Jay Scott, Tom Johnston, John Mainzer, Larry Watanabe, Jeff James, Vance Morrison, and Jeff Holden.

Availability

For further information about MacSHAPA and for copies of Sanderson et al. (in press), please contact:

Chris Sharbaugh, CSERIAC
Technology Transfer Analyst
Commercial: (513) 255-4842
DSN: 785-4842
FAX: (513) 255-4823.

For information about MacSHAPA workshops and training, please contact:

Penelope M. Sanderson
Email: psanders@ux1.cso.uiuc.edu.
FAX: (217) 244-6534.

Penelope M. Sanderson, Ph.D., is an Associate Professor of Mechanical and Industrial Engineering and of Psychology, University of Illinois at Urbana-Champaign.

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Mailing Address

To maintain *Gateway* as a free publication, it is necessary for us to keep the costs down. You can help us do that by making sure we have your correct address and notifying us of duplicate mailings. Also, if you know of anyone who would like to be added to our mailing list, please have them contact us.

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Request for Topics For State-of-the-Art Reports (SOARS)

CSERIAC makes every effort to be sensitive to the needs of its users. Therefore, we are asking you to suggest possible topics for future SOARS that would be of value to the Human Factors/Ergonomics community. Previous SOARs have included *Hypertext: Prospects and Problems for Crew System Design* by Robert J. Glushko, and *Three Dimensional Displays: Perception, Implication, Applications* by Christopher D. Wickens, Steven Todd, & Karen Seidler. Your input would be greatly appreciated. We are also looking for sponsors of future SOARs. CSERIAC is a contractually convenient, cost-effective means to produce rapid authoritative reports.

Send your suggestions and other replies to
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AL/CFH/CSERIAC Bldg 248
ATTN: Dr. Ron Schopper,
Chief Scientist
2255 H Street
Wright-Patterson AFB OH 45433-7022

Going Behind the Label "Human Error"

Leila Johannesen

Human error is often cited as a major contributing factor or "cause" of incidents and accidents. Incident surveys in aviation have attributed 70% of incidents to crew error and similar percentages are found in other industries. As a result, there is a perception of a "human error problem" in large, complex systems. If we adopt this conventional view, what can we do to improve safety? The options are few: we can try to train people to remediate the apparent deficiencies in their behavior, we can try to remove the culprits from the scene, or we can try to police practitioner activities more closely.

A new CSERIAC state-of-the-art report (SOAR), *Behind Human Error: Cognitive Systems, Computers, and Hindsight* (D. D. Woods, L. Johannesen, R. I. Cook, & N. Sarter, The Ohio State University), suggests a quite different approach. Over the past 15 years, a more complicated story of how complex systems fail has emerged, with different implications for countermeasures. System failures are a form of information about the system in which people are embedded. They do not point to a single independent and human culprit as the source of failure. Instead, system failures indicate the need for an analysis of the decisions and actions of individuals and groups embedded in the larger system that provides resources and imposes constraints. To study human performance and system failure requires studying the function of the system in which practitioners are embedded. In general, failures tell us about situations where knowledge is not brought to bear effectively, where the attentional demands are extreme, or where conflicts and double binds are created.

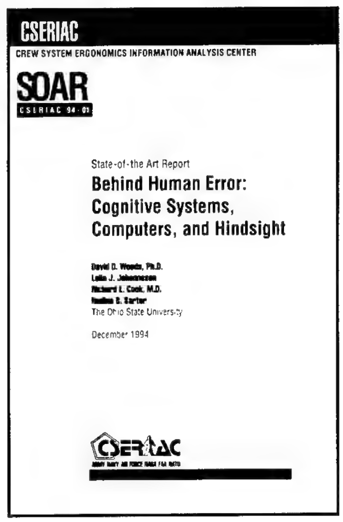

Figure 1. Behind Human Error: Cognitive Systems, Computers, and Hindsight (Woods, Johannesen, Cook, & Sarter, 1994).

The behavior that people deem "human error" should mark the starting point for investigation rather than its end. What appears on the surface to be human error committed by a practitioner at the "sharp end" should be regarded as an alarm bell that warns of problems further upstream toward the "blunt end" of the system. In this book we discuss the larger system within which practitioners operate and show how factors such as organizational processes and the design of new computer technology impact their cognition and behavior. These factors set up demands that shape the cognitive activities of the sharp-end practitioners. For example, the organizational context can influence the strategic dilemmas that practitioners face, creating goal conflicts. We discuss how these factors are kinds of "latent" failures that can contribute to incidents and accidents.

The first part of the book presents a set of basic premises or themes that summarize many of the important ideas behind the label of human error. It provides an overview of the results of the intense and cross-disciplinary examination of error and disaster that has been going on since about 1980. We then explore three main themes behind the label of human error:

- The role of cognitive system factors in incidents,
- How the clumsy use of computer technology can increase the potential for erroneous actions and assessments, and
- The hindsight bias and how attributions of error are a social and psychological judgment process rather than a matter of objective fact.

The demands that large, complex systems operations place on human performance are mostly cognitive. In the second part of the book we focus on cognitive factors related to the expression of expertise and error. The difference between expert and inexpert human performance is shaped, in part, by three classes of cognitive factors: knowledge factors, attentional dynamics, and strategic factors. However, these cognitive factors do not apply just to an individual but also to teams of practitioners. In addition, the larger organization places constraints that shape how practitioners meet the demands of their field of practice.

One of the basic themes that has emerged in more recent work on error is the need to model team and organizational factors. We integrate individual, team, and organizational perspectives by viewing operational systems as distributed human-machine cognitive systems. This portion of the book lays out the cognitive processes carried out across a distributed system

Continued on page 16

that govern the expression of expertise as well as error in real systems. It explores some of the ways that these processes go off-track or break down and increase the vulnerability to erroneous actions.

The third part of the book addresses the clumsy use of new technological possibilities in the design of computer-based devices and shows how certain designs can create the potential for erroneous actions and assessments. We draw on examples from various domains including medicine, aviation, and space. One typical kind of breakdown in the interaction between people and machines that we highlight is *mode error*. Some of the questions addressed include:

- What are these classic design flaws in human-computer systems, computer-based advisors, and automated systems?
- Why do we see them so frequently in so many settings?
- How do devices with these characteristics shape practitioner cognition and behavior?
- How do practitioners cope with the complexities introduced by clumsy use of technological possibilities?
- What do these factors imply about the human contribution to risk and to safety?

The fourth part of the book examines how hindsight biases the possibilities for error analysis. It shows how attribution of error is a social and psychological judgment process rather than a matter of objective fact. Hindsight leads us to see only those forks in the road that practitioners decided to take; we see "the view from one side of a fork in the road, looking back" (Lubar, 1993). This view is fundamentally flawed because it does not reflect the situation confronting the practitioners at the scene. The challenge we face as evaluators of human performance is to reconstruct what the view was like or would have been like had we stood on the same road.

We end the book with a re-examination of what human error is and some guidance on how to develop high-reliability organizations. Rather than being a causal category, human error represents a symptom, a piece of information, and a starting point for investigation. One can go behind the label by understanding how systemic factors affect the cognition and behavior of those at the sharp end of practice. ●

Behind Human Error: Cognitive Systems, Computers, and Hindsight is available from the CSERIAC Program Office for $39. To order, please call (513) 255-4842 or DSN 785-4842, FAX (513) 255-4823.

Leila Johannesen is a Co-author of Behind Human Error: Cognitive Systems, Computers, and Hindsight and a Cognitive Engineer/Psychologist in the Cognitive Systems Engineering Laboratory, Department of Industrial and Systems Engineering, The Ohio State University, Columbus, OH.

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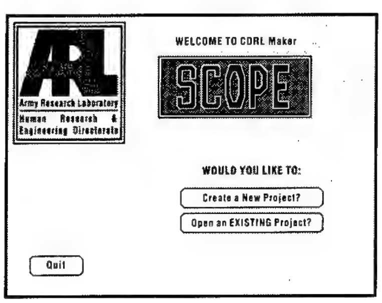
SCOPE IT OUT!

Smart Contract Preparation Environment from the U.S. Army Research Laboratory



SCOPE (Smart COntract Preparation Environment)

Two software programs intended to assist in the preparation of the request for proposal (RFP). Both programs run on a Macintosh Computer System 6.8 or higher.

SPEC Maker - to facilitate the tailoring of two commonly used HFE design standards (MIL-STD-1472D, *Human Engineering Design Criteria for Military Systems, Equipment, and Facilities*, and MIL-STD-1474C, *Noise Limits for Military Materiel*) for incorporation in the system specifications.

CDRL Maker - to facilitate the preparation of DD Forms 1423, the Contract Data Requirements List, and the tailoring of the human engineering Data Item Descriptions (DIDs), DD Forms 1664.

Price: $35 each. For further information on SCOPE and its two products, SPEC Maker and CDRL Maker, contact the CSERIAC Technology Transfer Analyst at (513) 255-4842.

CSERIAC Review & Analysis

Nuclear Power Plants and Human-System Interfaces

Ken M. Klauer

Human factors information may be applied to virtually any system requiring human control or supervision. Some of the largest and most complex systems exist in the domain of nuclear power generation. These systems have benefited greatly from advances in microprocessor-based automated control technology, which has partially relieved the operator(s) from the daunting task of manually controlling these potentially dangerous systems. Unfortunately, this technology has advanced so rapidly that relatively little is known about the human operator's place in these new highly automated systems. What types of information must be presented to the human operator, and how should it be presented to help operators "stay on top of the system"?

The Nuclear Regulatory Commission (NRC) is currently developing review guidelines for the evaluation of future human-system interface (HSI) concepts in nuclear power plant control rooms (see Fig. 1). Historically, the NRC collected as much literature as they could and subjected this material to independent peer review–a time-consuming process. Because the NRC's work began in 1990, the source documents had to be published prior to that date. As a result, the NRC guidelines were thought to be timely. However, there were soon "gaps" in the resulting guidelines because the literature had not kept pace with accelerated technological change.

Unfortunately, several areas of emerging automation and display technology are anticipated to be included in future nuclear power plant control rooms, for which *no* acceptable guidelines are known to exist. It is vital for the NRC to obtain information on the most recent developments in the areas identified as gaps, so that the NRC staff can quickly pursue the most appropriate course of action.

To achieve this goal, CSERIAC provided the NRC with twelve comprehensive Review & Analyses addressing critical areas of concern in the next generation of automated nuclear power plants. The following topics were addressed in CSERIAC's reports:

- Graphic presentation of nuclear power plant concepts, status, information, and data.
- Automation interface monitoring and control methodologies.
- Large screen displays.
- Integration of advanced technology into conventional control rooms.
- Knowledge-based systems and intelligent operator aids.
- Flat panel display characteristics.
- Video display hardware characteristics.
- New input devices, soft switches, and multifunction displays and controls.
- Computer-based workstation integration.
- Computer-based control room layout and environment.
- Test and maintenance of digital systems.

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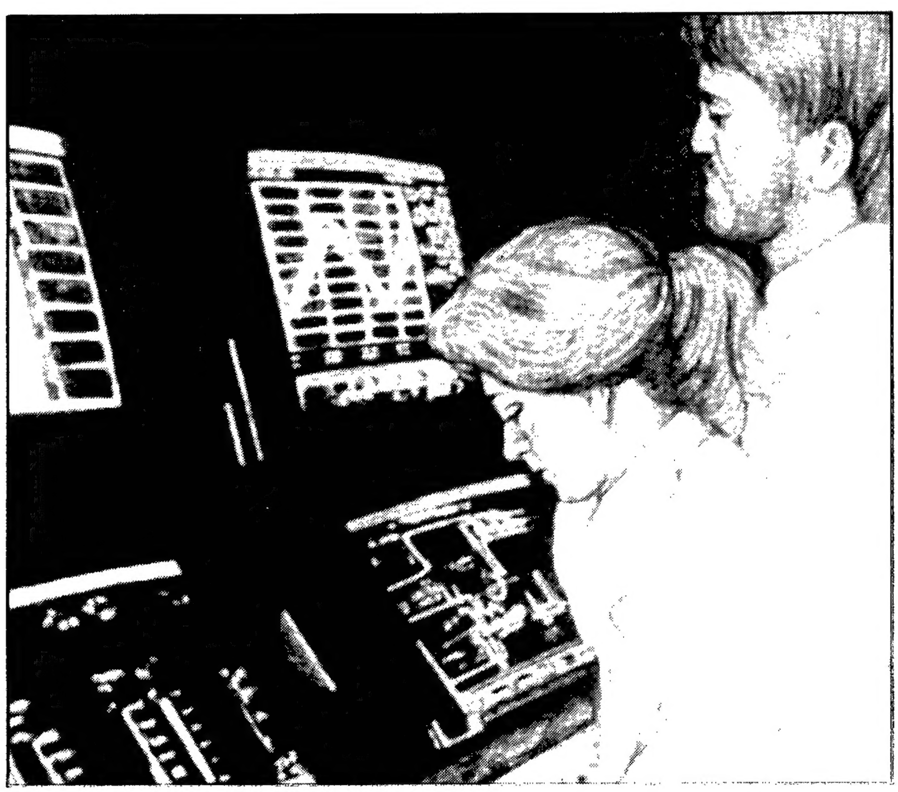


Figure 1. An example of a typical human-system interface in a nuclear power plant. Illustration by Ronald T. Acklin.

- Computer-based emergency operating procedures.

As a whole, these topics cover a wide range of human factors issues. Some of these topics addressed issues never before considered explicitly by the human factors community. Where previous applied research could not be found in the nuclear domain, CSERIAC's analysts had to consider literature that was highly theoretical, or applicable to similar process control environments such as continuous casting or petrochemical operations.

As part of each Review & Analysis, CSERIAC conducted comprehensive bibliographic searches and compiled a listing of the most relevant documents. CSERIAC analysts then reviewed the abstracts, identified the most pertinent documents, and acquired these documents for in-depth consideration. CSERIAC analysts also consulted extensive in-house library and database resources, and contacted several internationally known subject-matter experts (SMEs). The Review & Analysis reports provide an in-depth examination of the literature, and will enable the NRC staff to determine the most appropriate approach in the development of human-system interface guidelines. The results of each critical Review & Analysis, including the bibliographic search and SME points-of-contact, were integrated and bound together as a complete CSERIAC report on their respective topics.

The NRC benefited from CSERIAC's assistance in many ways. Foremost was CSERIAC's speed of response given the scale of this task; CSERIAC was able to provide initial drafts of all 12 reports within 10 weeks of their contracted commencement date. A complete Review & Analysis can normally be generated in 10 to 12 weeks, at a cost-recovery fee of only $4975.00–far below what it would cost our clients to produce a comparable product in house. Because CSERIAC analysts perform hundreds of searches annually, we are able to provide efficient literature review services. Also, while the NRC still must submit these documents for peer review, it is likely that this process will be smoother as each Review & Analysis represents a careful distillation of the topic literature. However, the source documents are referenced if the NRC wishes to explore specific aspects of any one of the twelve Review & Analyses. CSERIAC can provide complete copies or excerpts from relevant documents (except those limited by applicable DoD security regulations and general copyright laws), if requested.

A CSERIAC Review & Analysis can be a valuable asset to any project. Review & Analyses have been published on a number of human factors topics outside the nuclear power plant domain. Examples range from the effects of crew reductions on armored vehicle systems to the impact of various communications media on scientific and technical material. ●

For further information, contact a CSERIAC Human Factors Analyst at (513) 255-4842, DSN 785-4842, or email: CSERIAC@falcon.aamrl.wpafb.af.mil.

Ken Klauer is a Human Factors Analyst for CSERIAC.

■ STATE-OF-THE-ART IN HUMAN FACTORS ■

Naturalistic Decision Making: Implications for Design (Klein, 1993)

State-of-the-Art Reports (SOARs) available from CSERIAC:

Human Factors Issues in Head-Up Display Design: The Book of HUD (Weintraub & Ensing, 1992)

Hypertext: Prospects and Problems for Crew System Design (Glushko, 1990)

Strategic Workload and the Cognitive Management of Advanced Multi-Task Systems (Adams, Tenney, & Pew, 1991)

Three-Dimensional Displays: Perception, Implementation, Applications (Wickens, Todd, & Seidler, 1989)

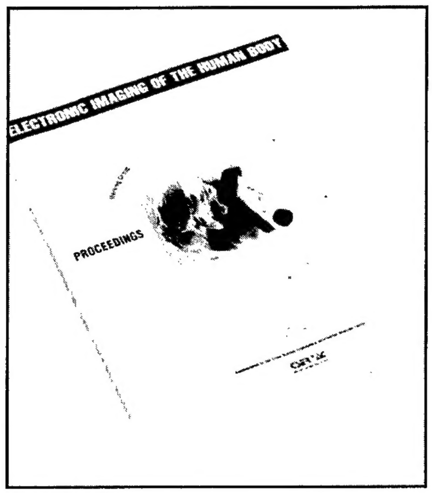
Naturalistic Decision Making: Implications for Design (Klein, 1993)

Price: $35 each. To order these SOARs or other CSERIAC Products, contact the CSERIAC Program Office at (513) 255-4842 or DSN 785-4842.

Proceedings of the Working Group on Electronic Imaging of the Human Body

Jennifer J. Whitestone

The Armstrong Laboratory Human Engineering Division, in cooperation with the Mallinckrodt Institute of Radiology; the Washington University School of Medicine; and the Lister-Hill National Center for Biomedical Communication, National Library of Medicine, hosted the first annual meeting of the Cooperative Working Group on Electronic Imaging of the Human Body. The working group, under the auspices of CSERIAC, brought together 31 researchers from government, industry, and academia working in the area of medical imaging and, more generally, image science, to discuss issues associated with collecting, archiving, transferring, visualizing, and analyzing image data. Although applications for three-dimensional (3-D) human body image data range from reconstructive surgery to designing protective equipment, the challenges faced by medical researchers, anthropometrists, educators, prosthodontists, and design engineers are the same: How can the images be captured quickly and accurately? Can the data be reduced to a manageable size for archiving, manipulating, and visualizing? How can the images be represented in an efficient, yet lossless format to allow for meaningful and timely analyses? What software tools and filters are available for handling the data? What databases of human body images currently exist and how can these images be made accessible to other researchers and physicians? What standards exist for image data and what methods or filters are available for implementing these standards? This working group has encouraged effective use of the resources from all the various disciplines involved in electronic imaging of the human body, identified immediate challenges associated with handling image data, and developed strategies for applications relevant to engineering, medicine, entertainment, and education. To address image data compatibility across numerous platforms and with applications software, this multi-disciplinary group will continue to provide direction for data format standards that will impact future industry standards.



Electronic Imaging of the Human Body (Vannier, Yates, & Whitestone, 1993).

Five topic areas were identified to assist in categorizing the position papers offered by each of the working group members. These areas include (1) development of surface scanning systems, (2) data storage and interchange format standards, (3) calibration, validation, and evaluation of scanning systems, (4) data analysis, image processing, and display, and (5) physically based modeling of deformable objects. The *Proceedings*, available through CSERIAC for $35, offer a brief overview of the progress and issues associated with each of these topic areas and provide a compilation of the position papers submitted by each of the 23 speakers.

Computer networks have revolutionized exchange and distribution of visualization technology in the form of "collaboratories." Collaboratories, a combination of the term "collaboration" and "laboratories," are an electronic extension of independent laboratories containing hardware, software, people, and databases, but are not limited to a physical space. Collaboratories can, in fact, contain many independent laboratories which are not collocated, but are connected electronically. The use of these networked relationships makes possible the effectiveness of this working group to initiate and continue electronic communication to support the objectives of this group. ●

Jennifer J. Whitestone is a Biomedical Engineer with the Design Technology Branch, Armstrong Laboratory Human Engineering Division, Wright-Patterson Air Force Base, OH.

Correction

In the last issue of the *CSERIAC Gateway* we inadvertently omitted a credit for a figure which we adapted for the article "Stooped vs. Squat Lifting Techniques" pp. 14-15. The figure caption should have read "Figure 1. An illustration of the L5-S1 area of the spine. (Adapted from K. H. E. Kroemer, H. J. Kroemer, & K. E. Kroemer-Elbert (1990). *Engineering Physiology: Bases of Human Factors/Ergonomics* (2nd Ed.). New York: Van Nostrand Reinhold.)" Our sincere apologies to the authors and publisher for this oversight.

ARMY NAVY AIR FORCE NASA FAA NATO

NEWS FROM the Defense Logistics Agency's

CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER

- IMPROVING TOTAL CONTACT BURN MASKS: THREE-DIMENSIONAL ANTHROPOMETRIC IMAGING TECHNIQUES
- CALENDAR
- COTR SPEAKS
- ANNOUNCEMENTS
- A CONVERSATION WITH RICHARD PEW
- MacSHAPA: SOFTWARE SUPPORT FOR OBSERVATIONAL DATA ANALYSIS
- GOING BEHIND THE LABEL "HUMAN ERROR"
- NUCLEAR POWER PLANTS AND HUMAN-SYSTEM INTERFACES
- PROCEEDINGS OF THE WORKING GROUP ON ELECTRONIC IMAGING OF THE HUMAN BODY
- CSERIAC PRODUCTS AND SERVICES

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CSERIAC PRODUCTS AND SERVICES

CSERIAC's objective is to acquire, analyze, and disseminate timely information on crew system ergonomics (CSE). The domain of CSE includes scientific and technical knowledge and data concerning human characteristics, abilities, limitations, physiological needs, performance, body dimensions, biomechanical dynamics, strength, and tolerances. It also encompasses engineering and design data concerning equipment intended to be used, operated, or controlled by crew members.

CSERIAC's principal products and services include:

- technical advice and assistance;
- customized responses to bibliographic inquiries;
- written reviews and analyses in the form of state-of-the-art reports and technology assessments;
- reference resources such as handbooks and data books.

Within its established scope, CSERIAC also:

- organizes and conducts workshops, conferences, symposia, and short courses;
- manages the transfer of technological products between developers and users;
- performs special studies or tasks.

Services are provided on a cost-recovery basis. An initial inquiry to determine available data can be accommodated at no charge. Special tasks require approval by the Government Technical Manager.

To obtain further information or request services, contact:

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CSERIAC Gateway is published and distributed free of charge by the Crew System Ergonomics Information Analysis Center (CSERIAC). *Editor:* Jeffrey A. Landis; *Copy Editor:* R. Anita Cochran; *Illustrators:* Ronald T. Acklin, Timothy J. Span; *Layout Artist:* Ronald T. Acklin; *Ad Designer:* Kristen Cheevers.